**INVESTIGATION OF RELIANCE ON FLASH TUBE LACQUER SEALS FOR PROPER PERFORMANCE IN MEDIUM-CALIBER AMMUNITION SUCH AS GAU-8/A AND LW30**

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## ABSTRACT

This investigation studied the dynamic rupture pressures of the lacquer seal on the flash tube found in GAU-8/A and LW30 medium-caliber ammunition. The maximum pressure inside the flash tube was found to be near 42 MPa. At this pressure, significant gas generation would be achieved before the flash tube vented into the main propellant bed. Hot gas/particle flow at these pressures is expected to play a significant role in ignition of the main propellant charge and rapid functioning of the round.

## 1. INTRODUCTION

GAU-8/A and other 30-mm ammunition such as the LW30 family use a flash tube (Figure 1) to augment the ignition stimulus of the primer and to provide an ignition source for the propellant bed in each round. The flash tube is filled with an igniter material such as black powder and receives the reaction products from the primer (at the left of Figure 1) as an ignition source. The lacquer seal on the output end of the flash tube is thought by some to do more than just keep the black powder in the flash tube. It should be sufficiently strong so that the primer output remains in the flash tube until the black powder is ignited and combustion products from the black powder have built up enough pressure and hot particle density. When it does rupture, the pressure released, with the accompanying gas flow, should be sufficiently high to increase the pressure in the propellant bed so that the initial burning rate of the propellant is high enough to propel the projectile to the muzzle within the few milliseconds that constitute the action time of the appropriate cannon. Missions that rely on weaponry such as the Apache helicopter M230 cannon require dependable and reliable operation of the ammunition. Misfire and/or prolonged action time can produce deleterious effects on the equipment and reduced lethality of the system.

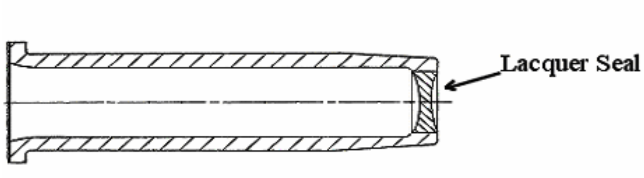


Fig. 1. Schematic of flash tube used in tests.

A previous study (Howard, 2003) of the rupture pressure of the flash tube lacquer seal at up to rupture pressures of 78 MPa indicated that significant gas generation would be achieved before the flash tube vented into the main propellant bed. Gas flow at these pressures is expected to play a significant role in the ignition of the main propellant charge and rapid functioning of the round. However, that study only examined pressurized flash tubes venting into open air. This study examines the functioning of black powder filled flash tubes in open air and in an inert propellant bed to simulate actual functioning of the flash tube.

## 2. EXPERIMENTAL

The experiments were conducted on two test fixtures at the U.S. Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD, USA. Figure 2 shows a simplified schematic of a fixture to test the dynamic rupture pressure of a flash tube lacquer seal as experienced by the flash tube. The flash tube was filled with the standard charge of 350 mg Class VI black powder and held in the fixture. An electric match provided the ignition stimulus and was placed behind the black powder in a void volume that was approximately the same as that of the conventional primer. The pressure was monitored with a pressure transducer behind the electric match.

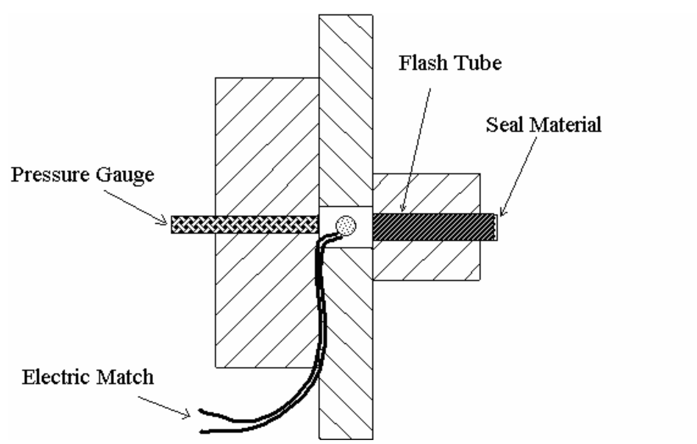


Fig. 2. Simplified schematic of open air fixture to obtain the dynamic rupture pressure of a flash tube seal.

The second fixture simulated the inside of an M789 from the LW30 family of ammunition. This simulator was filled with inert propellant. The simulator was a modification of an existing 25-mm ballistic simulator at ARL (Chang, 1992). The black powder in the flash tube

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was ignited by an electric match and its pressure monitored in similar manner as in Figure 2. Pressure in the propellant bed region was measured near the projectile location and near the breech.

## 3. RESULTS

If the flash tube seal malfunctions, the gas flow from the flash tube is expected to be different and thereby change the functioning of the round. Several seal rupture tests with simulated damaged seals were performed in the fixture in Figure 2 to investigate this condition. These pressure-time histories (Figure 3) show dramatic differences when compared to results of proper functioning seals. Upon examination of the table downstream from the vented flash tube with the damaged seal, unburned particles of black powder were found; such particles were not found with a properly functioning seal. These particles were ejected from the flash tube instead of burning.

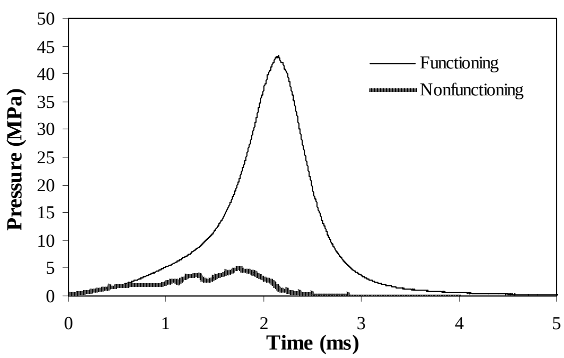


Fig. 3. Pressure-time histories in the flash tube of functioning and nonfunctioning lacquer seals.

If the functioning and nonfunctioning flash tubes were mounted in the ballistic simulator and the pressures in both the flash tube and in the propellant bed monitored, large differences were also noticed as shown in Figures 4 and 5 (the pressures in the propellant bed were magnified by a factor of 5 in order to be easily visible in Figure 4; the bed pressures in Figure 5 require a factor of 50 to be seen).

In Figure 4, the maximum pressure in the functioning flash tube was about 42 MPa prior to rupture at near 1.7 ms. The breech pressure began to rise steeply at 2.2 ms to approximately 2 MPa by 2.8 ms and the forward pressure rose more slowly to the same pressure by approximately 4 ms. The pressure then decreased, as is typical with heat loss from the gases to the inert grains after the propellant (black powder in this case) has burned out. The test of a damaged seal produced a different pressure-time history as shown in Figure 5. The pressure in the flash tube reached a maximum pressure of 2.5 MPa in 1.5 ms, but did not begin to fully vent until approximately 3 ms. At this point the pressure in the propellant bed began rising and continued rising for approximately 4 ms until it reached a maximum pressure of approximately 0.02 MPa that held steady for at least 15 ms. Such pressure behavior could indicate that black powder particles left the flash tube without burning and entered the propellant bed prior to combusting.

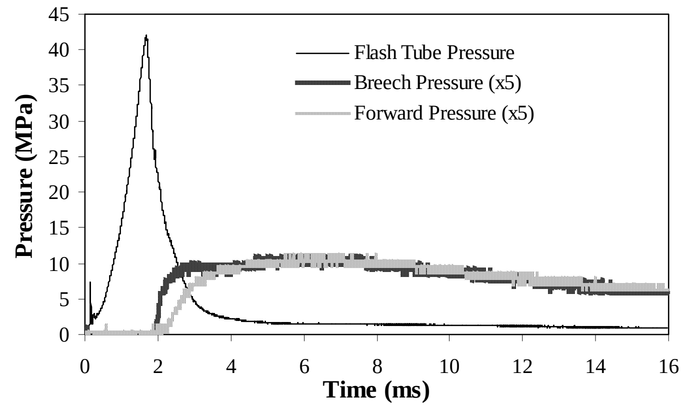


Fig. 5. Pressure-time histories for a properly functioning seal in the ballistic simulator

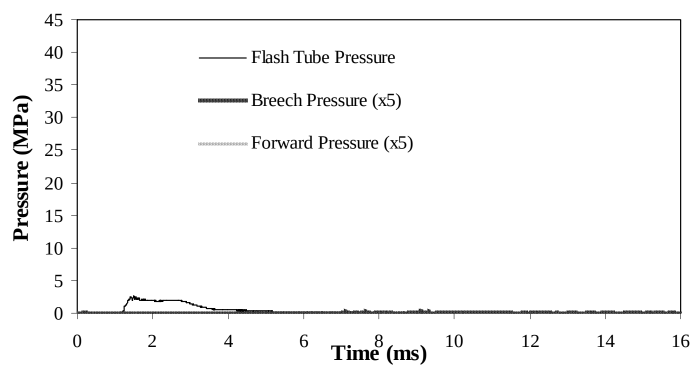


Fig. 5. Pressure-time histories for a nonfunctioning seal in the ballistic simulator.

## CONCLUSIONS

The lacquer seal on a flash tube for 30-mm ammunition was shown to perform more functions than a simple environmental seal. Use of fixtures that vented the output from the flash tube into open air or into an inert propellant bed demonstrated that proper functioning of the seal could greatly affect the conditions present during the early-phase combustion of the propellant bed. With damaged or defective seals, pressure in the propellant bed decreased dramatically.

## REFERENCES


Chang, L. M., 1992: Interior Ballistic Simulations of 25-mm Gun Charges; *BRL-TR-3330*; U.S. Army Ballistic Research Laboratory, Aberdeen Proving Ground, MD.

Howard, S. L., 2004: Flash Tube Lacquer Seal Dynamic Rupture Strength in 30-mm Ammunition, *Propellants, Explosives, Pyrotechnics*. **28**(5), 256-258.